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# Observations on the Life History of *Diplectrum pacificum* and *D. macropoma* (Pisces, Serranidae) from the Bay of Panama[1]

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ABSTRACT: *Diplectrum pacificum* and *D. macropoma* were collected in abundance from January through February 1973 at a depth of 20–30 m in the Bay of Panama. Juvenile *D. pacificum* apparently occur in shallow water (less than 2 m). The substrate where adults of both species occur sympatrically is fine sand and silt bottom with some shell.

Both species display nearly identical negative allometric growth. *Diplectrum pacificum* reaches a maximum size of 219 mm standard length. The oldest specimens were from age-group 6. *Diplectrum macropoma* attains a maximum size of 130 mm standard length. The oldest specimens were from age-group 4. Both species tend to aggregate in definite size groups.

Both species feed predominately on small shrimp and other crustaceans. *Diplectrum pacificum* tends to select larger shrimp than does *D. macropoma*. Reproductively, both species are synchronous hermaphrodites. Testicular tissue is restricted to a morphologically distinct, species-specific area. Mature eggs pass into an ovarian sinus before being deposited. Sperm and ovarian ducts exit separately. No evidence was found of internal self-fertilization in either species. Behaviorly, both species show an affinity for the substrate and display color patterns that are similar to the active-inactive color pattern described for another related species, *D. formosum*.

THE GENUS *Diplectrum* is currently composed of nine Pacific and three Atlantic fish species (Rosenblatt and Johnson 1974; Bortone 1973, 1974). In general, the species inhabit coastal demersal areas at moderate depth. These colorful sea basses are usually less than 300 mm standard length (SL), and bear an enlarged preopercle which is important taxonomically. All congeneric species thus far recognized are thought to be synchronously hermaphroditic, that is, ovarian and testicular tissue are present and presumably functional in adult individuals (Bortone 1973, 1974).

*Diplectrum pacificum* Meek & Hildebrand, 1925, occurs along the outer Baja California coast at Bahía San Juanico, in the Gulf of California, and southward to Ecuador. It is generally found in coastal areas over mud or mud-sand bottom in 15–30 m depth but has been found from 0.1–90 m (Bortone 1973). It is of potential economic importance, as it is abundant in the catch of shrimp trawlers. Berdegue (1956) indicated that the species is of economic importance to Mexico and presented some fishery data to support his statement. Except for these observations the life history or general ecology of the species has not been studied previously.

*Diplectrum macropoma* (Günther 1864) is most often captured between depths of 20–40 m but has been captured at depths ranging from 9–80 m (Bortone 1973). *Diplectrum macropoma* is also found in the Gulf of California, northward to near Isla de Santa Margarita on the outer Baja California, southward to the Ecuador-Peruvian border, and at the Galápagos Islands. Fishery data presented by Berdegue (1956) for *D. pacificum* are also applicable for *D. macropoma*. No life history data other than depth and distribution are presently known for *D. macropoma*.

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During January and February 1973, I was able to obtain a large series of specimens of *D. pacificum* and *D. macropoma* from the Bay of Panama. Herein several aspects of the life histories of both species are compared.

## SPECIMENS EXAMINED

### *Diplectrum pacificum*

14 specimens (23–60 mm SL), 20 January 1973, Bay of Panama, W side of Naos Island, depth 1.5 m, salinity 29‰, temperature 27°–29° C, 3 m × 1 m seine; 11 specimens (30–80 mm SL), Bay of Panama, W side of Naos Island, depth 2 m, salinity 32‰, temperature 26° C, 3 m × 1 m seine; 1 specimen (135 mm SL), 22 January 1973, Bay of Panama, 100–400 m E of Naos Island, depth 2–8 m, salinity 32‰, temperature 26° C, 7 m otter trawl; 103 specimens (64–214 mm SL), 25 January 1973, 6–20 km ESE of Naos Island, depth 20–30 m, salinity 32‰, temperature 26° C, 10 m otter trawl; 29 specimens (168–219 mm SL), 6 February 1973, 6–20 km ESE of Naos Island, depth 20–30 m, salinity 35‰, temperature 23° C, 10 m otter trawl. Total number of specimens: 158.

### *Diplectrum macropoma*

75 specimens (79–130 mm SL), 25 January 1973, Bay of Panama, 6–20 km ESE of Naos Island, depth 20–30 m, salinity 32‰, temperature 26° C, 10 m otter trawl; 53 specimens (34–127 mm SL), 6 February 1973, Bay of Panama, 6–20 ESE of Naos Island, depth 20–30 m, salinity 35‰, temperature 23° C, 10 m otter trawl. Total number of specimens: 128.

## MATERIALS AND METHODS

Standard length was measured to the nearest millimeter on specimens larger than 100 mm SL and to the nearest .1 millimeter on specimens smaller than 100 mm SL. Wet weight of 10-percent Formalin-preserved specimens was recorded to the nearest .1 gram. Both sagitta otoliths were placed in glycerine for clearing and storage after they had been removed from fresh specimens. The right otolith was aged, whenever possible, according to Bortone (1971) except that the otolith radius was measured from the central core along the dorsal axis. This procedure was necessary, as the anterior and posterior otolith projections were often broken. Back calculations were conducted following Poole (1961). Stomachs (including the esophagus but excluding the intestine posterior to the pyloric valve) were removed from Formalin-preserved specimens. Stomach contents were sorted, identified, and enumerated as to frequency of occurrence, number, and wet weight to the nearest .1 gram, according to Windell (1968). Observations of behavior were conducted on juveniles of *D. pacificum* in 5-liter aquaria and on adults of both species in a 9 m × 7 m × 1.5-m-deep holding tank.

Histological examinations were conducted on the gonads of 10 (123–210 mm SL) *D. pacificum* and 14 (78–130 mm SL) *D. macropoma*. Gonads were removed from live specimens and fixed for 3 days in Bouin's fixative. Dehydration, infiltration, and embedding was conducted according to Bortone (in press). Gonads were sectioned at 7–12 μm, serially mounted, and stained in hematoxylin and orange G, Mallory's analine blue-orange G-acid fuchsin (Galigher and Kozloff 1964), or in periodic acid-Schiff (Davenport 1960).

## OBSERVATIONS

### *Habitat*

Juvenile and small adult (less than 135 mm SL) *D. pacificum* were captured from shallow (less than 8 m) inshore areas around Naos Island. The bottom in these areas was composed of fine sand and silt and included a small amount of shell hash. Smallest specimens were taken from the shallowest areas in a silt-bottom cove on the west side of Naos Island. Although the shallowest water from which *D. pacificum* was captured was 1.5 m, a collection from the University of Arizona (UA 66–69) revealed a specimen (81 mm SL) taken from a 0.1-m-deep tide pool near Punta Peñasco in the Gulf of California.

Except for a few juveniles and small adults, generally only large adult *D. pacificum* were captured at the deeper sample sites (20–30 m). The bottom at these sites also was composed of fine sand and silt but included a larger portion of shell hash. The dual, 10-m, semiballoon

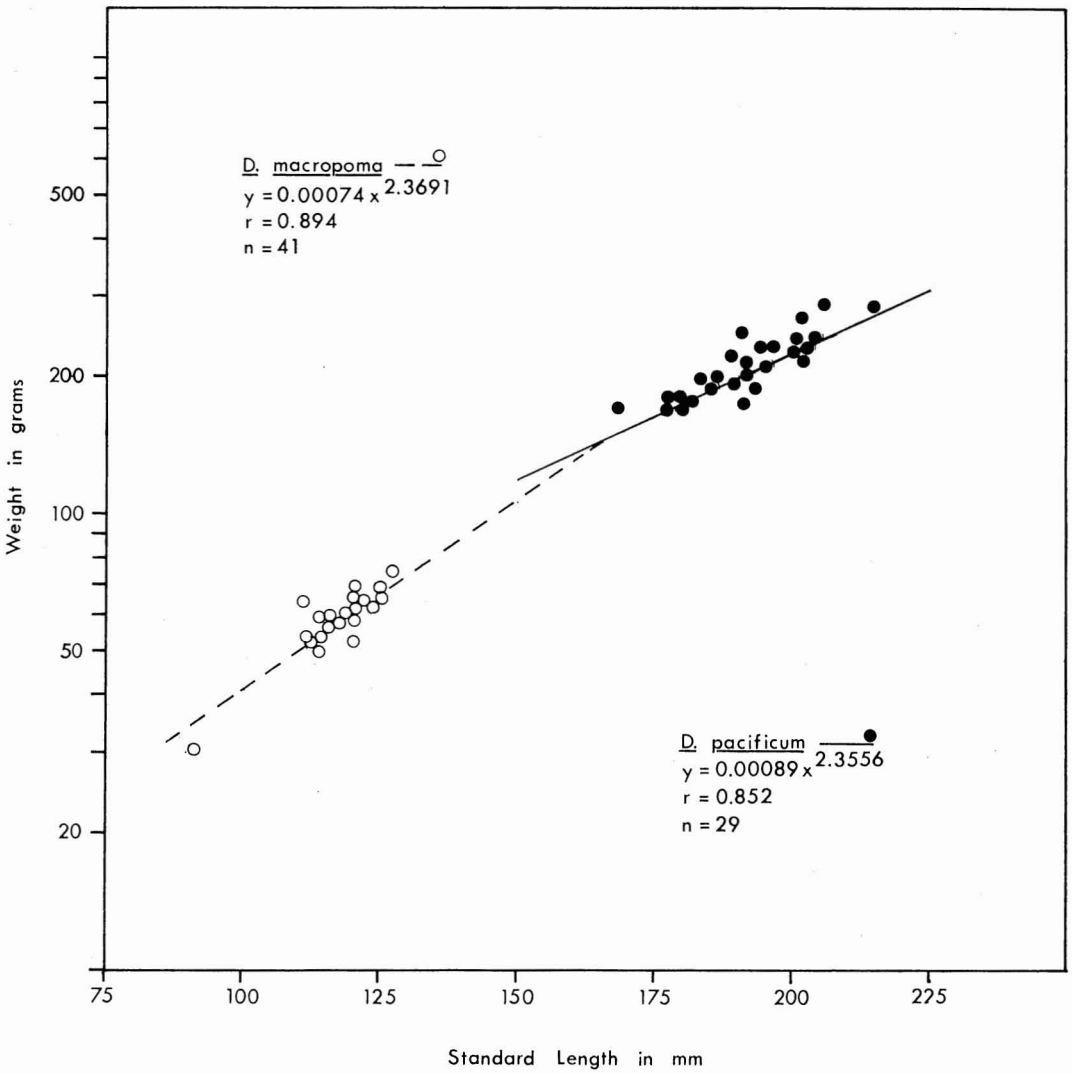


FIGURE 1. Length: weight relationships for *Diplectrum pacificum* and *D. macropoma*.

otter trawls yielded substantial numbers of specimens; each net obtained between 7–25 *D. pacificum* during a 15-min tow.

*Diplectrum macropoma* was not collected at any inshore site. All *D. macropoma* captured in the present study were obtained from the same 20–30-m-deep stations previously described for *D. pacificum*. *Diplectrum macropoma* was also abundant during the trawl samplings, as each 15-min net haul yielded 1–25 specimens.

*Length: Weight*

In a sample of 29 adult *D. pacificum*, the relationship of standard length to weight fits the equation $Y = 0.00089\ X^{2.3556}$, where $Y$ = wet weight in grams and $X$ equals standard length in millimeters; logarithmically: $\log Y = 2.3556 \log X - 3.0505$. The length: weight relationship for 41 *D. macropoma* is $Y = 0.00074\ X^{2.3691}$; logarithmically: $\log Y = 2.3691 \log X - 3.1286$. Using a *t*-test, we see that the correlation coefficients of +0.853 for *D. pacificum* and +0.894

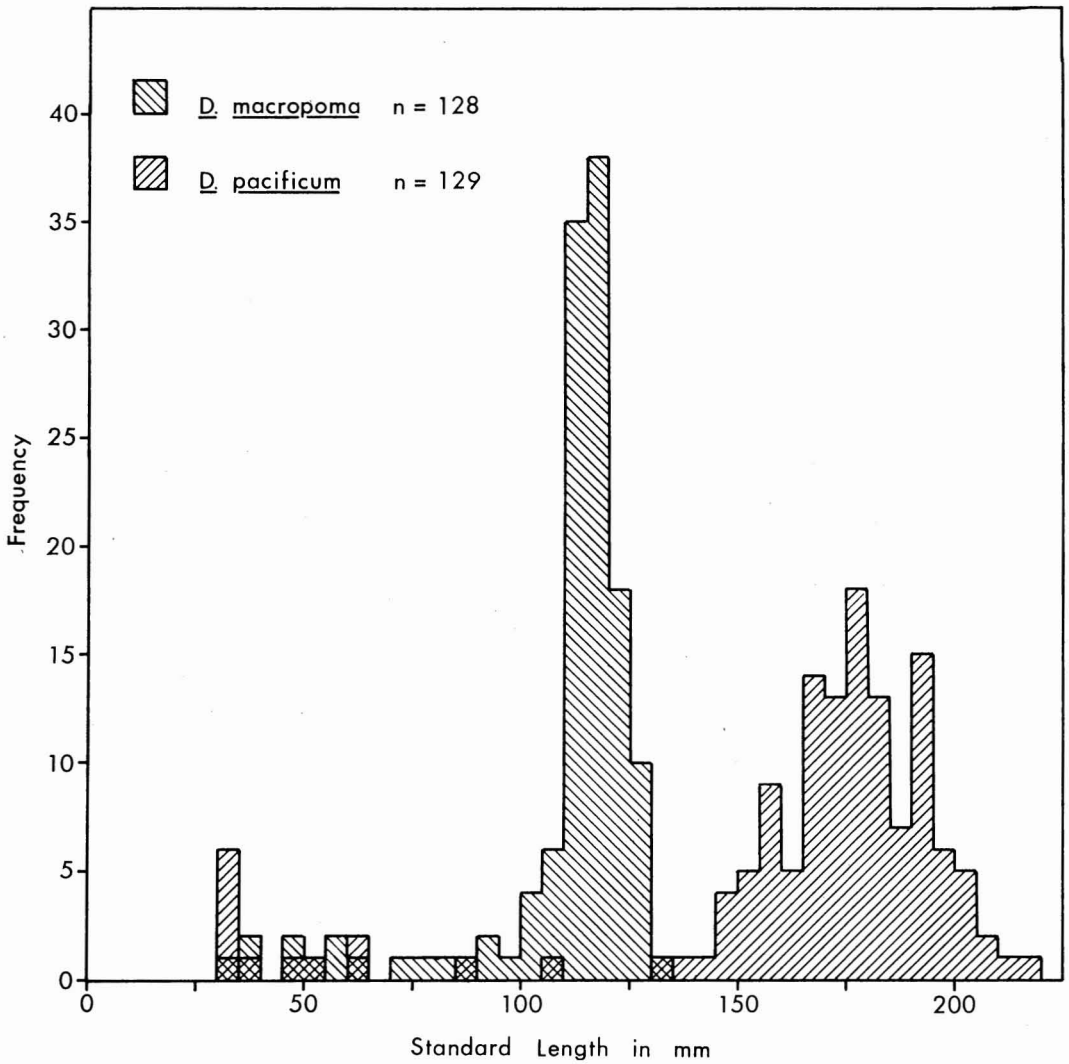


FIGURE 2. Length:frequency histograms for *Diplectrum pacificum* and *D. macropoma*.

for *D. macropoma* are both significant at the 5-percent level.

Published length:weight data for the congeneric Atlantic relative *Diplectrum formosum* showed a length:weight of

$$Y = 0.00935\ X^{3.0405}$$

for that species (Bortone 1971). Comparatively speaking, the length exponents are quite similar between *D. pacificum* and *D. macropoma* (Figure 1), but both species apparently differ from *D. formosum*. The approximate isometric growth of *D. formosum* contrasts with the negative allometric growth for *D. pacificum* and *D. macropoma*.

### *Length:Frequency*

A length:frequency histogram is presented in Figure 2. These data imply a rather unimodel size distribution for both species. However, several points must be raised. The apparent dominance of a single size group for both species in the Bay of Panama during January–February

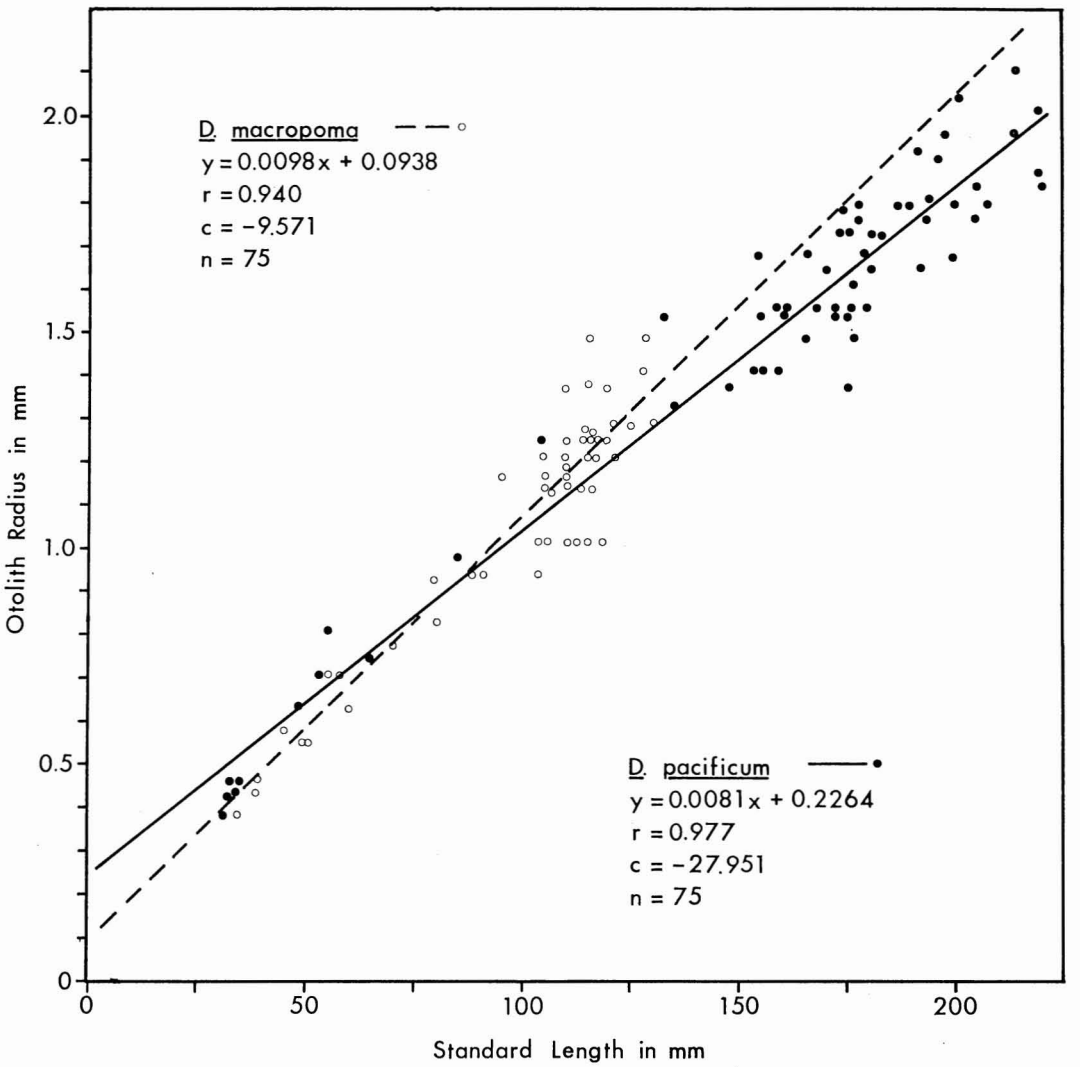


FIGURE 3. Relationships of otolith radius versus standard length for *Diplectrum pacificum* and *D. macropoma*.

1973 may be due to several reasons: (1) the relatively large sample sizes collected from two generally overlapping areas of the bay, (2) the size selectivity of the 30-m otter trawls, or (3) the relatively ineffective sampling procedures at inshore areas where juveniles apparently predominate. Although the length:frequency histogram presents little information concerning the age-group structure of these species, it does indicate the relative size-classes that predominate in the Bay of Panama. *Diplectrum pacificum* and *D. macropoma* were collected sympatrically as adults in depths of 20–30 m in the Bay of Panama. The size-groups present in this area are nearly mutually exclusive. Little or no overlap in size-class seemed to occur in the areas where competition between the species is apt to be greatest.

### *Age-and-Growth Data*

Age-groups were determined and annulus radii recorded to determine the standard length at the time of annulus formation through a back-

TABLE 1

BACK-CALCULATED STANDARD LENGTHS IN MILLIMETERS FOR *Diplectrum pacificum* FROM THE BAY OF PANAMA

| YEAR-CLASS | NUMBER OF FISH | ANNULUS 1 $\bar{x}$ | 1 S.D. | 2 $\bar{x}$ | 2 S.D. | 3 $\bar{x}$ | 3 S.D. | 4 $\bar{x}$ | 4 S.D. | 5 $\bar{x}$ | 5 S.D. | 6 $\bar{x}$ | 6 S.D. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | 9 | 26.16 | 7.11 | | | | | | | | | | |
| 1971 | 3 | 17.49 | 6.28 | 51.29 | 7.83 | | | | | | | | |
| 1970 | 1 | 19.13 | — | 61.92 | — | 87.60 | | | | | | | |
| 1969 | 10 | 28.57 | 7.56 | 66.69 | 10.12 | 103.65 | 19.21 | 133.80 | 19.63 | | | | |
| 1968 | 45 | 28.64 | 8.31 | 68.47 | 10.67 | 103.64 | 12.59 | 135.97 | 13.29 | 163.17 | 14.22 | | |
| 1967 | 7 | 24.56 | 9.62 | 61.78 | 9.75 | 104.53 | 8.65 | 135.92 | 11.30 | 161.60 | 16.46 | 182.67 | 21.28 |
| Mean Standard Length at Annulus | | 27.38 | 8.31 | 65.97 | 11.10 | 103.64 | 13.13 | 135.64 | 14.05 | 162.96 | 14.38 | 182.67 | 21.28 |
| Growth increase | | 27.38 | | 38.59 | | 37.67 | | 32.00 | | 27.32 | | 19.71 | |
| Number of Fish | | 75 | | 66 | | 63 | | 62 | | 52 | | 7 | |

calculation procedure. Otolith radius was regressed against standard length. The linear least-square analysis equations are

$$Y = 0.0081\ X + 0.2264$$

for *D. pacificum* and

$$Y = 0.0098\ X + 0.0938$$

for *D. macropoma* (Figure 3). Correlation coefficients are +0.977 and +0.940 for *D. pacificum* and *D. macropoma*, respectively. A *t*-test shows that both values are acceptable at the 5-percent level of significance. Correction factors ($c$, where the regression line crosses the $X$ axis) obtained from the above data and necessarily applied to the back-calculated procedure of Poole (1961) are −27.95 for *D. pacificum* and −9.57 for *D. macropoma*.

The maximum age-group attained for *D. pacificum* was 6 (204 mm SL specimen). However, the majority of the population (52 out of 75) aged by otolith examination were from age-group 5 and were captured from the 20–30-m-deep sample sites.

Table 1 presents age-and-growth data as determined by back-calculation of those *D. pacificum* for which age groups could be determined. This table presents the size of specimens at time of annulus formation. *Diplectrum pacificum* tends to form its first annulus at 27.38 mm SL. Calculated growth increments for specimens attaining age-group 2 was largest at 38.59 mm. That gradual reduction in annual growth increment occurred may be seen in Table 1 and Figure 4.

Maximum age recorded for *D. macropoma* was age-group 4 (Table 2). The largest specimen aged in the present study was a 123-mm SL specimen from age-group 3. The majority of specimens (53 out of 75) from the 20–30-m-deep sample sites were from age-group 3. Back-calculated growth data indicate that *D. macropoma* forms its first annulus at an average size of 34.7 mm SL, or at a slightly larger size than that of *D. pacificum*. Growth in specimens beyond age-group 1 is reduced and appears to approach an asymptote at age-group 4.

Relatively high standard deviations have been calculated for time of first annulus formation in *D. pacificum* and *D. macropoma* (8.31 and 7.16, respectively). This size variability for young specimens may be due to a prolonged spawning period, which is typical of tropical species. Other factors, such as irregular growth rates caused by temporally and spatially uneven prey distribution and/or the relative abundance of year-classes, may be responsible. Since all specimens were collected during a single brief season, no conclusion is acceptable at present regarding the time of annulus formation.

Bortone (1971) has shown that *D. formosum* attains a maximum size of 223 mm SL and a maximum age-group of 6. Also, *D. formosum* forms its first annulus at an average of 34.7 mm SL, and a maximum growth increment occurs between age-groups 2 and 3. Apparently

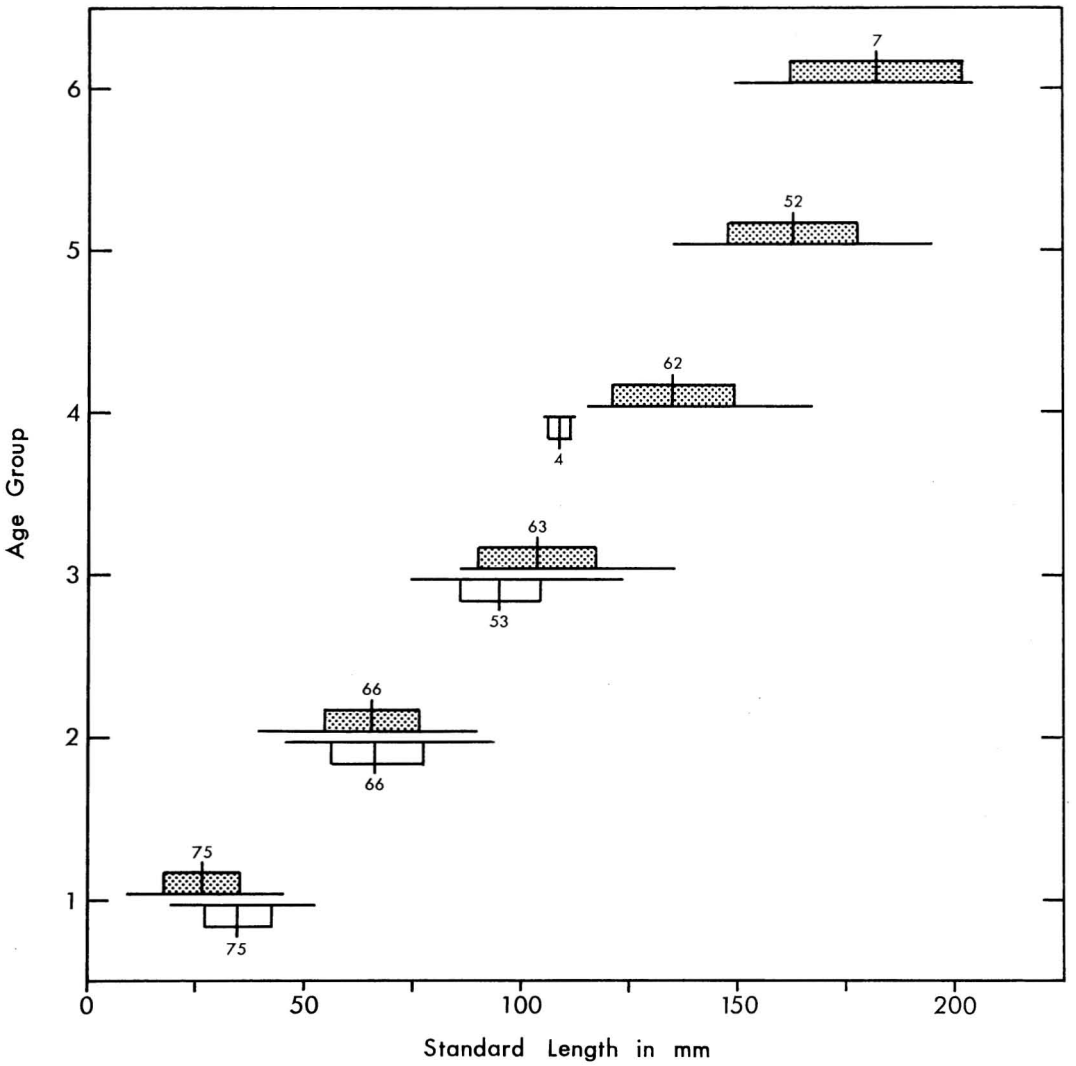


FIGURE 4. Back-calculated standard lengths at annulus (age-group) formation. Vertical lines indicate means; horizontal lines indicate the range; the enclosed area represents ± one standard deviation. (shaded, *D. pacificum*; open, *D. macropoma*)

*D. pacificum* most resembles *D. formosum* in terms of age, size, and growth, but *D. macropoma* most resembles *D. formosum* in terms of size at first annulus formation.

### *Stomach Analyses*

A summary of stomach analyses is presented in Table 3. All specimens examined in the present study were from the 6 February 1973 trawl station in which adults of both species occurred sympatrically.

Crustaceans appear as the most important food type for both sea basses in terms of occurrence, number of items, and weight. However, a closer examination reveals several features of the diets which may imply competitive exclusion. *Diplectrum pacificum* ate appreciably more fish than did *D. macropoma* (24.8 percent versus 0.4 percent by weight). Also, there was a decided tendency for *D. pacificum* to eat larger but fewer shrimp and for *D. macropoma* to eat more but smaller shrimp. The shrimp, chiefly *Sicyonia disdorsalis* (Penaeidae), were

TABLE 2

BACK-CALCULATED STANDARD LENGTH IN MILLIMETERS FOR *Diplectrum macropoma* FROM THE BAY OF PANAMA

| YEAR-CLASS | NUMBER OF FISH | ANNULUS 1 $\bar{x}$ | 1 S.D. | 2 $\bar{x}$ | 2 S.D. | 3 $\bar{x}$ | 3 S.D. | 4 $\bar{x}$ | 4 S.D. |
|---|---|---|---|---|---|---|---|---|---|
| 1972 | 9 | 31.82 | 5.95 | | | | | | |
| 1971 | 13 | 36.82 | 9.43 | 77.56 | 13.40 | | | | |
| 1970 | 49 | 34.77 | 6.42 | 64.65 | 9.47 | 96.02 | 9.06 | | |
| 1969 | 4 | 33.24 | 10.39 | 59.78 | 8.95 | 89.63 | 2.88 | 108.64 | 2.42 |
| Mean Standard Length at Annulus | | 34.70 | 7.16 | 66.90 | 11.52 | 95.54 | 8.90 | 108.64 | 2.42 |
| Growth Increase | | 34.70 | | 32.20 | | 28.64 | | 13.10 | |
| Number of Fish | | 75 | | 66 | | 53 | | 4 | |

measured for total length (anterior tip of rostrum to posterior tip of telson) whenever possible. Forty-six shrimp eaten by 29 *D. pacificum* (mean SL = 191.28) averaged 44.11-mm total length (TL) (standard deviation = 10.57), and 73 shrimp eaten by 37 *D. macropoma* (mean SL = 115.57) averaged 33.04-mm TL (standard deviation = 12.85). A *t*-test showed that these means are significantly different at the 5-percent level of significance. The competitive exclusion principle apparently operates in the predatory roles displayed by *D. pacificum* and *D. macropoma*. Although food items do not decidedly differ, a notable difference does occur in relative preferences in food size of *D. pacificum* and *D. macropoma* when they occur sympatrically.

Bortone (1971) accorded *D. formosum* the role of an euryphagic carnivore in the benthic community in the northern Gulf of Mexico. *Diplectrum pacificum* and *D. macropoma* may be accorded the same role in the Bay of Panama, with feeding emphasis for all three *Diplectrum* spp. being on natant crustaceans.

### *Reproduction*

All specimens of *D. pacificum* and *D. macropoma* examined indicate that both species function reproductively as synchronous hermaphrodites. Both species display "territorial hermaphroditism" (*sensu* D'Ancona 1952); testicular tissue is distinctly separated from ovarian tissue. In *D. pacificum*, ovarian tissue is confined to two anteriorly projecting lobes that join posteriorly. Mature eggs pass through a central ovarian lumen and posteriorly enter an ovarian sinus where the eggs apparently are retained until they are deposited through an oviduct originating in the floor of the ovarian sinus. Testicular tissue is confined to a broad band surrounding the gonad in the region just posterior to the point where the ovarian lobes join. Spermatozoa pass through a sperm duct that extends over the posterior surface of the gonad and exits through a genital papilla alongside the urinary duct (see Bortone, in press, for a detailed discussion of gonad morphology in *D. pacificum*).

*Diplectrum macropoma* displays a slightly different type of "territorial hermaphroditism". The testicular tissue is much broader, covering nearly the entire posterior and ventral gonadal surface, and tends to encroach more on the posterior ovarian sinus than does testicular tissue in *D. pacificum*.

Flagellated spermatozoa were present in all acinus crypts, collecting ducts, and sperm ducts in specimens of *D. pacificum* examined histologically. Smaller *D. macropoma* (3 specimens, 78–93 mm SL) had testicular tissue that contained nonflagellated spermatids. Larger *D. macropoma* (11 specimens, 86–130 mm SL) had flagellated spermatozoa in the crypts and ducts. The ducts and collecting tubes in the testicular tissue appeared to be filled with proportionately fewer spermatozoa in *D. macropoma* than in *D. pacificum*.

Several features of the ovarian tissue are common to both species. Specimens of *D. paci-*

TABLE 3

SUMMARY OF STOMACH ANALYSES FROM 29 *Diplectrum pacificum* AND 37 *D. macropoma*

| ITEM | O | % O | *N* | % *N* | W | % W |
|---|---|---|---|---|---|---|
| | | *D. pacificum* | | | | |
| Class Crustacea | 36 | 69.2 | 57 | 76.0 | 70.7 | 72.2 |
| Superorder Eucarida | | | | | | |
| Order Decapoda | | | | | | |
| Suborder Natantia | | | | | | |
| Section Penaeidea | 25 | 48.1 | 45 | 60.0 | 55.4 | 56.6 |
| Family Penaeidae | | | | | | |
| Section Caridea | | | | | | |
| Family Alphaidae | | | | | | |
| Family Palaemanetes | 1 | 1.9 | 1 | 1.3 | 0.7 | 0.7 |
| Suborder Reptantia | | | | | | |
| Section Brachyura | | | | | | |
| Family Portunidae | 1 | 1.9 | 1 | 1.3 | 0.2 | 0.2 |
| Superorder Hoplocarida | | | | | | |
| Order Stomatopoda | | | | | | |
| Family Squillidae | 6 | 11.5 | 7 | 9.3 | 13.3 | 13.7 |
| Unidentified Crustacea | 3 | 5.8 | 3 | 4.0 | 1.1 | 1.1 |
| Class Mollusca | | | | | | |
| Order Cephalopoda | 1 | 1.9 | 1 | 1.3 | 2.4 | 2.5 |
| Class Osteichthyes | 13 | 25.0 | 17 | 22.7 | 24.3 | 24.8 |
| Unidentified contents | 1 | 1.9 | | | 0.5 | 0.5 |
| Empty | 1 | 1.9 | | | | |
| TOTAL | 52 | | 75 | | 97.9 | |
| | | *D. macropoma* | | | | |
| Class Crustacea | 55 | 91.7 | 118 | 96.7 | 45.4 | 98.7 |
| Superorder Eucarida | | | | | | |
| Order Decapoda | | | | | | |
| Suborder Natantia | | | | | | |
| Section Penaeidea | 29 | 48.3 | 75 | 61.4 | 33.4 | 72.6 |
| Family Penaeidae | | | | | | |
| Section Caridea | | | | | | |
| Family Alphaidae | 4 | 6.7 | 4 | 3.3 | 1.0 | 2.2 |
| Family Palaemanetes | | | | | | |
| Suborder Reptantia | | | | | | |
| Section Brachyura | | | | | | |
| Family Portunidae | 2 | 3.3 | 3 | 2.5 | 1.0 | 2.2 |
| Superorder Hoplocarida | | | | | | |
| Order Stomatopoda | | | | | | |
| Family Squillidae | 12 | 20.0 | 14 | 11.5 | 7.7 | 16.7 |
| Unidentified Crustacea | 8 | 13.3 | 22 | 18.0 | 2.3 | 5.0 |
| Class Mollusca | | | | | | |
| Order Cephalopoda | 1 | 1.7 | 1 | 0.8 | 0.4 | 0.9 |
| Class Osteichthyes | 3 | 5.0 | 3 | 2.5 | 0.2 | 0.4 |
| Unidentified Contents | | | | | | |
| Empty | 1 | 1.7 | | | | |
| TOTAL | 60 | | 122 | | 46.0 | |

NOTE: O, frequency of occurrence; *N*, number of items present; W, wet weight in grams.

*ficum* examined have all the oocyte stages, including eggs undergoing atresia (oocyte stages defined according to Hayashi 1972), present in various numbers.

In *D. macropoma* the 78-mm SL specimen has no oocyte development beyond the chromatin-nucleolus stage; the 82- and 86-mm SL specimens have none beyond the perinucleolus stage;

TABLE 4

OOCYTE DIAMETER IN MICRONS

| OOCYTE STAGE | *Diplectrum pacificum* | *Diplectrum macropoma* |
|---|---|---|
| Oogonium | 6–23 | 6–23 |
| Chromatin-Nucleolus | 29–57 | 23–63 |
| Perinucleolus | 57–66 | 51–71 |
| Yolk Vesicle | 80–100 | 79–85 |
| Primary Yolk | 114–151 | 90–140 |
| Secondary Yolk | 285 | 142–290 |
| Tertiary Yolk | 350 | 245–285 |
| Migratory Nucleus | 350 | 285 |
| Mature | 370–465 | 390–406 |

specimens larger than 86 mm SL had all oocyte stages present, including atretic eggs, although most specimens exhibited a decided predominance of chromatin-nucleolus oocytes.

In both species, a particular oocyte stage is likely to predominate in general areas of ovarian tissue; e.g., primary yolk stage oocytes are more numerous in the anterior-ventral portions. Thus, a gonad contains several or all stages of oocyte development simultaneously. Few mature eggs were present in the central lumen and none in the ovarian lamellae. Mature eggs were often present but never numerous (less than 50) in the ovarian sinus.

Table 4 presents a summary of the sizes of oocytes at the respective stages found in *D. pacificum* and *D. macropoma* during the study period. Morphology and color of the oocytes compare favorably with the oocyte descriptions of Hayashi (1972) for *Lateolabrax japonicus*.

### *Behavior*

Because the water in the Bay of Panama was quite turbid and visibility was less than 2 m at the shallower inshore sites during the study period, no field observations were possible. However, observations were made on the behavior of nine juvenile *D. pacificum* (30–80 mm SL) kept in aquaria for 26 days. Juvenile *D. pacificum* behaved in a manner similar to that described for *D. formosum* (Bortone 1971). Individuals seemed to adapt quickly to the aquaria and readily ate pieces of frozen shrimp and fish. During normal daylight hours, juveniles tended to alternate between "resting" (i.e., sitting on the substrate balanced on both extended pelvic fins and anal fin) and "hovering" (i.e., maintaining a position about one-half to one full body length above the substrate, tail slightly lower than head. During the night, the fish tended to spend most of the time resting, with infrequent brief hovering. Color patterns during "active" and "inactive" periods were as those described for *D. formosum*. During active hovering or swimming, the fishes' bodies are traversed laterally by two dark brown horizontal stripes. The more ventral of the two passes through the eye and onto the snout where it meets a stripe from the opposite side of the body. This dark brown stripe also extends to the caudal peduncle and terminates in a discernible caudal spot that is nearly as large as the eye and is almost confluent with the lateral band. During resting activity, the lateral pair of stripes becomes lighter at irregular intervals, giving the appearance of seven to eight vertical bars. The caudal spot during this phase appears to be completely disjunct from the lateral stripe pigmentation.

Adult *D. pacificum* displayed rather active swimming behavior when first placed in a large holding tank; however, after 8–10 hours, they became inactive. Their inactive behavior can anthropomorphically be described as "listless"; specimens remained on the substrate with neither pelvic nor anal fins extended for support. Adults did not feed on cut fish and shrimp but on two occasions consumed two adult specimens of *D. macropoma* that were also being maintained in the holding tank. An active-inactive color pattern was not observed during the 10-day observation period. Juvenile *D. pacificum* placed in the larger holding tank behaved as described previously.

Two adult *D. macropoma* were placed in the large holding tank together with several *D. pacificum*. Their behavior was identical to that described for adult *D. pacificum*. An active-inactive pattern was not observed for *D. macropoma*.

## DISCUSSION

Both species apparently inhabit the same general area within the Bay of Panama and are representatives of the demersal fish fauna in the

soft bottom areas of moderate depth. Although few data are available at present, I suspect that both species are thermophilic fishes that can withstand some fluctuations in salinity.

The nearly identical allometric growth observed for both species suggest that there may be little difference between the species in terms of metabolism or in obvious behavioral patterns such as migration. In contrast to *D. formosum*, related species in a higher latitude might be expected to tend toward isometric growth rather than negative allometry. Larger, deeper-bodied, heavier individuals have been noted to occur more frequently at higher rather than lower latitudes (Hubbs 1926).

Like other related species in the subfamily Serraninae for which life history data are available (e.g., *Serraniculus pumilio* [Hastings 1973] and *D. formosum* [Bortone 1971]) both species in the present study tended to eat a wide variety of small organisms but showed a definite preference for small crustaceans.

Self-fertilization has been observed under artificial conditions in other related synchronous hermaphrodites (Clark 1959, Reinboth 1962). Most authors believe that the natural reproductive mode in synchronously hermaphroditic Serranidae is that of paired spawning. No further evidence has been presented in this paper to support or detract from this view. However, the abundance of both *D. pacificum* and *D. macropoma* at some localities suggests either that they form a mass spawning group or that individuals may be promiscuous with other individuals in a spawning area.

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